APPENDIX A
ENVIRONMENTAL IMPACTS METHODOLOGIES

This appendix briefly describes the methods used to assess the potential direct, indirect, and cumulative effects of the alternatives in this *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory (CMRR EIS).* Included are impact assessment methods for land use and visual resources, site infrastructure, air quality, noise, geology and soils, surface and groundwater, water quality, ecological resources, cultural and paleontological resources, socioeconomics, waste management and pollution prevention, and cumulative impacts. Each section includes descriptions of the affected resources, region of influence, and impact assessment methods. Descriptions of the methods for the evaluation of human health effects from normal operations, facility accidents, and environmental justice are presented in Appendices B, C, and D, respectively.

Impact analyses vary for each resource area. For air quality, for example, estimated pollutant emissions from the candidate facilities were compared with appropriate regulatory standards or guidelines. Comparison with regulatory standards is a commonly used method for benchmarking environmental impacts and is done here to provide perspective on the magnitude of identified impacts. For waste management, waste generation rates were compared with the capacities of waste management facilities. Impacts within each resource area were analyzed consistently; that is, the impact values were estimated using a consistent set of input variables and computations. Moreover, calculations in all resource areas used accepted protocols and up-to-date models.

The baseline conditions assessed in this EIS are consistent with the Expanded Operations Alternative described in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (*LANL SWEIS*) (DOE 1999) and also consider present actions at the site. The No Action Alternative was used as the basis for the comparison of impacts that would occur under implementation of the other alternatives.

A.1 LAND USE AND VISUAL RESOURCES

A.1.1 Land Use

A.1.1.1 Description of Affected Resources and Region of Influence

Land use includes the land on and adjacent to each candidate site, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. The region of influence for land use varies due to the extent of land ownership, adjacent land use patterns and trends, and other geographic or safety considerations, but generally includes the site and areas immediately adjacent to the site.

A.1.1.2 Description of Impact Assessment

The amount of land disturbed and conformity with existing land use were considered in order to evaluate impacts at each candidate site from construction and operation (see **Table A–1**). Both factors were considered for each of the action alternatives. However, since new construction would not take place under the No Action Alternative, only conformity with existing land use was evaluated for this alternative. Land-use impacts could vary considerably from site to site, depending on the extent of new construction and where it would take place (that is, on undeveloped land or within a previously disturbed area).

Table A–1 Impact Assessment Protocol for Land Resources

	Required Data		
Resource	***Affected Environment***	***Alternative***	***Measure of Impact***
Land area used	Site acreage	Facility location and acreage requirement	Acreage converted to project use
Compatibility with existing or future facility land use	Existing facility land use configurations	Location of facility on the site; expected modifications of facility activities and missions to accommodate the alternatives	Incompatibility with existing or future facility land use
Visual resources	Current Visual Resource Management classification	Location of facility on the site; facility dimensions and appearance	Change in Visual Resource Management classification

A.1.2 Visual Resources

A.1.2.1 Description of Affected Resources and Region of Influence

Visual resources are the natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape; however, they exert varying degrees of influence. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape. The region of influence for visual resources includes the geographic area from which the candidate facilities may be seen.

A.1.2.2 Description of Impact Assessment

Impacts to visual resources from construction and operation of the proposed action at LANL may be determined by evaluating whether the Bureau of Land Management Visual Resource Management classifications of the candidate sites would change as a result of the proposed action (DOI 1986) (see Table A–1). Existing classifications were derived from an inventory of scenic qualities, sensitivity levels, and distance zones for particular areas. For those alternatives involving existing facilities at LANL, alterations to visual features may be readily evaluated and the impact on the current Visual Resource Management classification determined. In order to determine the range of potential visual effects from new facilities, the analysis considered potential impacts from construction and operation in light of the aesthetic quality of surrounding areas, as well as the visibility of the proposed action from public vantage points.

A.2 SITE INFRASTRUCTURE

A.2.1 Description of Affected Resources and Region of Influence

Site infrastructure includes the physical resources required to support the construction and operation of the candidate facilities. It includes the capacities of onsite road and rail transportation networks; electric power and electrical load capacities; natural gas capacities; and water supply system capacities.

The region of influence is generally limited to the boundaries of the candidate technical areas at LANL. However, should infrastructure requirements exceed technical area or site capacities, the region of influence would be expanded (for analysis) to include the sources of additional supply. For example, if electrical demand at LANL (with added facilities) exceeded availability, then the region of influence would be expanded to include the likely source of additional power.

A.2.2 Description of Impact Assessment

In general, infrastructure impacts were assessed by evaluating the requirements of each alternative against the technical area capacities. An impact assessment was made for each resource (transportation, electricity, fuel, and water) for the various alternatives (see **Table A–2**). Local transportation impacts were addressed qualitatively, as transportation infrastructure requirements under the proposed action were considered negligible. Tables reflecting site availability and infrastructure requirements were developed for each alternative. Data for these tables were obtained from reports describing the existing infrastructure at the sites, and from the data reports for each alternative. If necessary, design mitigation considerations conducive to reduction of the infrastructure demand were also identified.

Table A–2 Impact Assessment Protocol for Infrastructure

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Transportation - Roads (kilometers) - Railroads (kilometers)	Technical area/site capacity and current usage	Facility requirements	Additional requirement (with added facilities) exceeding technical area/site capacity
Electricity - Energy consumption (megawatt-hours per year) - Peak load (megawatts)	Technical area/site capacity and current usage	Facility requirements	Additional requirement (with added facilities) exceeding technical area/site capacity
Fuel - Natural gas (cubic meters per year)	Technical area/site capacity and current usage	Facility requirements	Additional requirement (with added facilities) exceeding technical area/site capacity
Water (liters per year)	Technical area/site capacity and current usage	Facility requirements	Additional requirement (with added facilities) exceeding technical area/site capacity

Any projected demand for infrastructure resources exceeding site availability can be regarded as an indicator of environmental impact. Whenever projected demand approaches or exceeds capacity, further analysis for that resource is warranted. Often, design changes can mitigate the impact of additional demand for a given resource. For example, substituting fuel oil for natural

gas (or vice versa) for heating or industrial processes can be accomplished at little cost during the design of a facility, provided the potential for impact is identified early. Similarly, a dramatic spike or surge in peak demand for electricity can sometimes be mitigated by changes to operational procedures or parameters.

A.3 AIR QUALITY

A.3.1 Description of Affected Resources and Region of Influence

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could:

- endanger human health
- harm living resources and ecosystems
- damage material property
- impair or interfere with the comfortable enjoyment of life and other legitimate uses of the environment.

For the purpose of this *CMRR EIS*, only outdoor air pollutants were addressed. They may be in the form of solid particles, liquid droplets, gases, or a combination of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents that may be influenced by sunlight). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Thus, air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location can be described by comparing the concentrations of various pollutants in the atmosphere with the appropriate standards. Ambient air quality standards have been established by Federal and state agencies, allowing an adequate margin of safety for the protection of public health and welfare from the adverse effects of pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy; those below such standards, acceptable.

The pollutants of concern are primarily those for which Federal and state ambient air quality standards have been established, including criteria air pollutants, hazardous air pollutants, and other toxic air compounds. Criteria air pollutants are those listed in 40 CFR Part 50, "National Primary and Secondary Ambient Air Quality Standards." Hazardous air pollutants and other toxic compounds are those listed in Title I of the Clean Air Act, as amended (40 U.S.C. 7401 et seq.), those regulated by the National Emissions Standards for Hazardous Air Pollutants (40 CFR 61), and those that have been proposed or adopted for regulation by the applicable state, or are listed in state guidelines. States may set ambient standards that are more stringent than the national ambient air quality standards. The more stringent of the state or Federal standards for each site is shown in this document.

Areas with air quality better than the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants are designated as being in attainment, while areas with air quality worse

than the NAAQS for such pollutants are designated as nonattainment. Areas may be designated as unclassified when sufficient data for attainment status designation are lacking. Attainment status designations are assigned by county, metropolitan statistical area, consolidated metropolitan statistical area, or portions thereof, or air quality control regions. Air quality control regions designated by the U.S. Environmental Protection Agency (EPA) are listed in 40 CFR Part 81, "Designation of Areas for Air Quality Planning Purposes." LANL is located in an attainment area (40 CFR Sections 81.332).

For locations that are in an attainment area for criteria air pollutants, Prevention of Significant Deterioration regulations limit pollutant emissions from new or modified sources and establish allowable increments of pollutant concentrations. Three Prevention of Significant Deterioration classifications are specified, with the criteria established, in the Clean Air Act. Class I areas include national wilderness areas, memorial parks larger than 5,000 acres (2,020 hectares), national parks larger than 6,000 acres (2,430 hectares), and areas that have been redesignated as Class I. Class II areas are all areas not designated as Class I. No Class III areas have been designated (42 U.S.C. 7472, Title I, Section 162). Although LANL is in a Class II area, it is adjacent to the Bandelier National Monument and Wilderness Area Class I area (DOE 1999).

The region of influence for air quality encompasses an area surrounding a candidate site that is potentially affected by air pollutant emissions caused by the alternatives. The air quality impact area normally evaluated is the area in which concentrations of criteria pollutants would increase more than a significant amount in a Class II area (on the basis of averaging period and pollutant: one microgram per cubic meter for the annual average for sulfur dioxide, nitrogen dioxide and particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}); five micrograms per cubic meter for the 24-hour average for sulfur dioxide and PM_{10}; 500 micrograms per cubic meters for the eight-hour average for carbon monoxide; 25 micrograms per cubic meter for the three-hour average for sulfur dioxide; and 2,000 micrograms for the one-hour average for carbon monoxide [40 CFR Section 51.165]). Generally, this covers a few kilometers downwind from the source. Further, for sources within 60 miles (100 kilometers) of a Class I area, the air quality impact area evaluated would include the Class I area if the increase in concentration were greater than one microgram per cubic meter (24-hour average). The area of the region of influence depends on emission source characteristics, pollutant types, emission rates, and meteorological and topographical conditions. For the purpose of this analysis, impacts were evaluated at the site boundary and roads within the sites to which the public has access, plus any additional area in which contributions to pollutant concentrations are expected to exceed significance levels.

Baseline air quality is typically described in terms of pollutant concentrations modeled for existing sources at each candidate site and background air pollutant concentrations measured near the sites. For this analysis, concentrations for existing sources were obtained from the *LANL SWEIS* and from modeling of concentrations using recent emissions inventories and the Industrial Source Complex (ISCST3) model (EPA 1995, EPA 2000).

A.3.2 Description of Impact Assessment

Potential air quality impacts of pollutant emissions from construction and normal operations were evaluated for each alternative. This assessment included a comparison of pollutant concentrations from each alternative with applicable Federal and state ambient air quality standards (see **Table A–3**). If both Federal and state standards exist for a given pollutant and averaging period, compliance was evaluated using the more stringent standard. Operational air pollutant emissions data for each alternative were based on conservative engineering analyses.

For each alternative, contributions to offsite air pollutant concentrations were modeled on the basis of guidance presented in EPA's "Guidelines on Air Quality Models" (40 CFR Part 51, Appendix W). The EPA-recommended model ISCST3 (EPA 1995) was selected as an appropriate model to perform the air dispersion modeling because it is designed to support the EPA regulatory modeling program and predicts conservative worst-case impacts.

The modeling analysis incorporated conservative assumptions, which tend to overestimate pollutant concentrations. The maximum modeled concentration for each pollutant and averaging time was selected for comparison with the applicable standard. The concentrations evaluated were the maximum occurring at or beyond the site boundary and at a public access road, or other publicly accessible area within the site. Available monitoring data, which reflect both onsite and offsite sources, were also taken into consideration. Concentrations of the criteria air pollutants were presented for each alternative. Concentrations of hazardous and toxic air pollutants were evaluated in the public and occupational health effects analysis. At least one year of representative hourly meteorological data was used.

Table A–3 Impact Assessment Protocol for Air Quality

	Required Data		
Resource	***Affected Environment***	***Alternative***	***Measure of Impact***
Criteria air pollutants and other regulated pollutants [a]	Measured and modeled ambient concentrations (micrograms per cubic meter) from existing sources at site	Emission rate (kilograms per year) of air pollutants from facility; source characteristics (stack height and diameter, exit temperature and velocity)	Concentration of alternative and total site concentration of each pollutant at or beyond site boundary, or within boundary on public road compared to applicable standard
Toxic and hazardous air pollutants [b]	Measured and modeled ambient concentrations (micrograms per cubic meter) from existing sources at site	Emission rate (kilograms per year) of pollutants from facility; source characteristics (stack height and diameter, exit temperature and velocity)	Concentration of alternative and total site concentration of each pollutant at or beyond site boundary, or within boundary on public road used to calculate hazard quotient or cancer risk

[a] Carbon monoxide; hydrogen fluoride; lead; nitrogen oxides; ozone; particulate matter with an aerodynamic diameter less than or equal to 10 microns; sulfur dioxide; total suspended particulates.

[b] Clean Air Act, Section 112, hazardous air pollutant; pollutants regulated under the National Emissions Standard for Hazardous Air Pollutants; and other state-regulated pollutants.

Ozone is typically formed as a secondary pollutant in the ambient air (troposphere). It is formed in the presence of sunlight from the mixing of primary pollutants, such as nitrogen oxides, and volatile organic compounds that emanate from vehicular (mobile), natural, and other stationary sources. Ozone is not emitted directly as a pollutant from the candidate sites. Although ozone may be regarded as a regional issue, specific ozone precursors, notably nitrogen dioxide and volatile organic compounds, were analyzed as applicable to the alternatives under consideration.

The Clean Air Act, as amended, requires that Federal actions conform to the host state's "state implementation plan." A state implementation plan provides for the implementation, maintenance, and enforcement of NAAQS for the six criteria pollutants: sulfur dioxide, particulate matter with an aerodynamic diameter less than or equal to 10 microns, carbon monoxide, ozone, nitrogen dioxide, and lead. Its purpose is to eliminate or reduce the severity and number of violations of NAAQS and to expedite the attainment of these standards. No department, agency, or instrumentality of the Federal Government shall engage in or support in any way (provide financial assistance for, license or permit, or approve) any activity that does not conform to an applicable implementation plan. The final rule for "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (58 FR 63214) took effect on January 31, 1994. LANL is within an area currently designated as attainment for criteria air pollutants. Therefore, the alternatives being considered in this *CMRR EIS* are not affected by the provisions of the conformity rule.

Emissions of potential stratospheric ozone-depleting compounds such as chlorofluorocarbons were not evaluated, as no emissions of these pollutants were identified in the conceptual engineering design reports.

A.4 NOISE

A.4.1 Description of Affected Resources and Region of Influence

Sound results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. Propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is undesirable sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities (hearing and sleep), damage hearing, or diminish the quality of the environment.

Sound-level measurements used to evaluate the effects of nonimpulsive sound on humans are compensated by an A-weighting scale that accounts for the hearing response characteristics (frequency) of the human ear. Sound levels are expressed in decibels (dB), or in the case of A-weighted measurements, decibels A-weighted (dBA). EPA has developed noise-level guidelines for different land use classifications. Some states and localities have established noise control regulations or zoning ordinances that specify acceptable noise levels by land use category.

Noise from facility operations and associated traffic could affect human and animal populations. The region of influence for each candidate site includes the site, nearby offsite areas, and

transportation corridors where proposed activities might increase noise levels. Transportation corridors most likely to experience increased noise levels are those roads within a few miles of the site boundary that carry most of the site's employee and shipping traffic.

Sound-level data representative of site environs were obtained from existing reports. The acoustic environment was further described in terms of existing noise sources for each candidate site.

A.4.2 Description of Impact Assessment

Noise impacts associated with the alternatives may result from construction and operation of facilities and from increased traffic (see **Table A–4**). Impacts from facility construction and operation were assessed according to the types of noise sources and the locations of the candidate facilities relative to the site boundary. Potential noise impacts from traffic were based on the likely increase in traffic volume. Possible impacts to wildlife were evaluated based on the possibility of sudden loud noises occurring during facility construction or modification and operation.

Table A–4 Impact Assessment Protocol for Noise

	Required Data		
Resource	***Affected Environment***	***Alternative***	***Measure of Impact***
Noise	Identification of sensitive offsite receptors (nearby residences); description of sound levels in the vicinity of the technical area/site	Description of major construction, modification, and operational noise sources; shipment and workforce traffic estimates	Increase in day/night average sound level at sensitive receptors

A.5 GEOLOGY AND SOILS

A.5.1 Description of Affected Resources and Region of Influence

Geologic resources include consolidated and unconsolidated earth materials, including mineral assets such as ore and aggregate materials, and fossil fuels such as coal, oil, and natural gas. Geologic conditions include hazards such as earthquakes, faults, volcanoes, landslides, sinkholes and other conditions leading to land subsidence, and unstable soils. Soil resources include the loose surface materials of the earth in which plants grow, usually consisting of mineral particles from disintegrating rock, organic matter, and soluble salts. Certain soils are considered important to farmlands, which are designated by the U.S. Department of Agriculture Natural Resources Conservation Service. Important farmlands include prime farmland, unique farmland, and other farmland of statewide or local importance as defined in 7 CFR 657.5 and may be subject to the Farmland Protection Policy Act (7 U.S.C. 4201 et seq.).

Geology and soils were considered with respect to those attributes that could be affected by the alternatives, as well as those geologic and soil conditions that could affect each alternative. Thus, the region of influence for geology and soils includes the project site and nearby offsite areas subject to disturbance by facility construction, modification, and operations under the alternatives, and those areas beneath existing or new facilities that would remain inaccessible for the life of the facilities. Geologic conditions that could affect the integrity and safety of facilities under the alternatives include large-scale geologic hazards (for example, earthquakes, volcanic

activity, landslides, and land subsidence) and local hazards associated with the site-specific attributes of the soil and bedrock beneath site facilities.

A.5.2 Description of Impact Assessment

Facility construction and operations for the *CMRR EIS* alternatives were considered from the perspective of impacts on specific geologic resources and soil attributes. Construction and facility modification activities were the focus of the impacts assessment for geologic and soil resources; hence, key factors in the analysis were the land area to be disturbed during construction and occupied during operations (see **Table A–5**). The assessment included an analysis of constraints to siting new CMRR Facilities over unstable soils prone to subsidence, liquefaction, shrink-swell, or erosion.

Table A–5 Impact Assessment Protocol for Geology and Soils

	Required Data		
Resource	***Affected Environment***	***Alternative***	***Measure of Impact***
Geologic hazards	Presence of geologic hazards within the region of influence	Location of facility on the site	Potential for damage to facilities
Valuable mineral and energy resources	Presence of any valuable mineral or energy resources within the region of influence	Location of facility on the site	Potential to destroy or render resources inaccessible
Important farmland soils	Presence of prime or other important farmland soils within the region of influence	Location of facility on the site	Conversion of important farmland soils to nonagricultural use

The geology and soils impact analysis (see Table A–5) also considered the risks to existing and new facilities of large-scale geologic hazards such as faulting and earthquakes, lava extrusions and other volcanic activity, landslides, and sinkholes (conditions that tend to affect broad expanses of land). This element of the assessment included collection of site-specific information on the potential for impacts on site facilities from local and large-scale geologic conditions. Historical seismicity within a given radius of each facility site was reviewed as a means of assessing the potential for future earthquake activity. As used in this EIS, earthquakes are described in terms of several parameters as presented in **Table A–6**.

Probabilistic earthquake ground motions in terms of peak ground acceleration and spectral (response) acceleration were determined in order to provide a comparative assessment of seismic hazard. The U.S. Geological Survey National Seismic Mapping Project uses both parameters. The U.S. Geological Survey's latest National Earthquake Hazards Reduction Program (NEHRP) maps are based on spectral acceleration and have been adapted for use in the *International Building Code* (ICC 2000) and depict maximum considered earthquake ground motion of 0.2- and 1.0-second spectral acceleration, respectively, based on a 2 percent probability of exceedance in 50 years (corresponding to an annual probability of occurrence of about 1 in 2,500). Available site-specific seismic hazard analyses were also reviewed and compared.

An evaluation also determined if construction or operation of proposed facilities at a specific site could destroy, or preclude the use of valuable mineral or energy resources.

Pursuant to the Farmland Protection Policy Act of 1981 (7 U.S.C. 4201 et seq.), and its implementing regulations (7 CFR 658) the presence of important farmland including prime farmland was also evaluated. This act requires agencies to make Farmland Protection Policy Act evaluations part of the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) process, the main purpose being to reduce the conversion of farmland to nonagricultural uses by Federal projects and programs. However, otherwise qualifying farmlands in or already committed to urban development, land acquired for a project on or prior to August 4, 1984, and lands acquired or used by a Federal agency for national defense purposes are exempt from the Act's provisions (7 CFR 658.2 and 658.3).

Table A–6 The Modified Mercalli Intensity Scale of 1931, with Generalized Correlations to Magnitude, and Peak Ground Acceleration

Modified Mercalli Intensity [a]	*Observed Effects of Earthquake*	*Approximate Magnitude* [b]	*Peak Ground Acceleration* [c] *(g)*
I	Usually not felt except by a very few under very favorable conditions.	Less than 3	Less than 0.0017
II	Felt only by a few persons at rest, especially on the upper floors of buildings.	3 to 3.9	0.0017 to 0.014
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.		
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy object striking building. Standing motor cars rock noticeably.	4 to 4.9	0.014 to 0.039
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.		0.039 to 0.092
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5 to 5.9	0.092 to 0.18
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	6 to 6.9	0.18 to 0.34
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	7 to 7.9	0.34 to 0.65
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.		0.65 to 1.24
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.		1.24 and higher
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.	8 and higher	
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.		

[a] Intensity is a unitless expression of observed effects from earthquake-produced ground shaking. Effects may vary greatly between locations based on earthquake magnitude, distance from the earthquake, and local subsurface geology. The descriptions given are abbreviated from the Modified Mercalli Intensity Scale of 1931.

[b] Magnitude is an exponential function of seismic wave amplitude, related to the energy released. There are several "magnitude" scales in common use including local "Richter" magnitude, body-wave magnitude, surface wave magnitude, and moment magnitude. Each has applicability for measuring particular aspects of seismic signals and may be considered equivalent within each scale's respective range of validity.

[c] Acceleration is expressed as a percent relative to the earth's gravitational acceleration (g) (g = 980 centimeters per second squared). Given values are correlated to Modified Mercalli Intensity based on measurements of California earthquakes only (Wald et al. 1999).

Sources: Compiled from Wald et al. 1999, USGS 2002.

A.6 SURFACE AND GROUNDWATER QUALITY

A.6.1 Description of Affected Resources and Region of Influence

Water resources are surface and groundwater suitable for human consumption, aquatic or wildlife propagation, agricultural purposes, irrigation, or industrial/commercial purposes. The region of influence used for water resources encompasses those site and adjacent surface water and groundwater systems that could be impacted by water withdrawals, effluent discharges, and spills or stormwater runoff associated with facility construction and operational activities under the relocation alternatives.

A.6.2 Description of Impact Assessment

Determination of the impacts of the *CMRR EIS* alternatives on surface and groundwater quality consisted of a comparison of site-generated data and professional estimates regarding water use and effluent discharge with applicable regulatory standards, design parameters and standards commonly used in the water and wastewater engineering fields, and recognized measures of environmental impact. Certain assumptions were made to facilitate the impacts assessment: (1) that all water supply (production and treatment) and effluent treatment facilities would be approved by the appropriate permitting authority; (2) that the effluent treatment facilities would meet the effluent limitations imposed by the respective National Pollutant Discharge Elimination System permits; and (3) that any stormwater runoff from construction and operation activities would be handled in accordance with the regulations of the appropriate permitting authority. It was also assumed that, during construction, sediment fencing or other erosion control devices would be used to mitigate short-term adverse impacts from sedimentation, and that, as appropriate, stormwater holding ponds would be constructed to lessen the impacts of runoff on surface water quality.

A.6.2.1 Water Use and Availability

This analysis involved the review of engineering estimates of expected surface water and/or groundwater use and effluent discharge associated with facility construction and operation activities for each alternative, and the impacts on local and regional water availability in terms of quantity and quality. Impacts on water use and availability were generally assessed by determining changes in the volume of current water usage and effluent discharge as a result of the proposed activities (**Table A–7**). For facilities intending to use surface water, no credit was taken for effluent discharges back to surface waters or to the subsurface. The impact of discharging withdrawn groundwater to surface waters or back to the subsurface was also considered, as appropriate.

If the determination of impacts reflected an increase in water use or effluent discharge, then an evaluation of the design capacity of the water supply production and treatment facilities and the effluent treatment facilities, respectively, was made to determine whether the design capacities would be exceeded by the additional flows. If the combined flow (the existing flow plus those from the proposed activities) was less than the design capacity of the water supply systems and effluent treatment plants, then it was assumed that there would be no impact on water availability

for local users, or on receiving surface waters or groundwater from effluent discharges. Further, a separate analysis (see Section A.6.2.2) was performed as necessary to determine the potential for effluent discharge impacts on ambient surface water or groundwater quality based on the results of the effluent treatment capacity analysis.

Table A–7 Impact Assessment Protocol for Water Use and Availability

	Required Data		
Resource	***Affected Environment***	***Facility Design***	***Measure of Impact***
Surface water availability	Surface waters near the facilities, including average flow and current usage	Volume of withdrawals from, and discharges to, surface waters	Changes in availability to local/ downstream users of water for human consumption, irrigation, or animal feeding
Groundwater availability	Groundwater near the facilities, including existing water rights for major water users and current usage	Volume of withdrawals from, and discharges to, groundwater	Changes in availability of groundwater for human consumption, irrigation, or animal feeding

Because water withdrawals and effluent discharges from the site facilities were generally found not to exceed the design capacity of existing water supply systems or effluent treatment facilities, additional analyses were not performed.

A.6.2.2 Water Quality

The water quality impact assessment analyzed how effluent discharges to surface water, as well as discharges reaching groundwater, from the facilities under each alternative would directly affect current water quality. The determination of the impacts of the alternatives is summarized in **Table A–8** and consisted of a comparison of the projected effluent quality with relevant regulatory standards and implementing regulations under the Clean Water Act (33 U.S.C. 1251 et seq.), Safe Drinking Water Act (42 U.S.C. 300 (f) et seq.), state laws, and existing site permit conditions. The impacts analysis evaluated the potential for contaminants to affect receiving waters as a result of spills, stormwater discharges, and other releases under the alternatives. Separate analyses were conducted for surface water and groundwater impacts.

Table A–8 Impact Assessment Protocol for Water Quality

	Required Data		
Resource	***Affected Environment***	***Facility Design***	***Measure of Impact***
Surface water quality	Surface waters near the facilities in terms of stream classifications and changes in water quality	Expected contaminants and contaminant concentrations in discharges to surface waters	Exceedance of relevant surface water quality criteria or standards established in accordance with the Clean Water Act or state regulations and existing permits
Groundwater quality	Groundwater near the facilities in terms of classification, presence of designated sole source aquifers, and changes in quality of groundwater	Expected contaminants and contaminant concentrations in discharges that could reach groundwater	Contaminant concentrations in groundwater exceeding relevant standards or criteria established in accordance with the Safe Drinking Water Act or state regulations and existing permits

Surface Water Quality—The evaluation of surface water quality impacts focused on the quality and quantity of any effluents (including stormwater) to be discharged and the quality of the receiving stream upstream and downstream from the discharges. The evaluation of effluent quality featured review of the expected parameters, such as the design average and maximum flows, as well as the effluent parameters reflected in the existing or expected National Pollutant

Discharge Elimination System or applicable state discharge permit. Parameters of concern include total suspended solids, metals, organic and inorganic chemicals, and any other constituents that could affect the local environment. Any proposed water quality management practices were reviewed to ensure that any applicable permit limitations and conditions would be met. Factors that currently degrade water quality were also identified.

During facility modification or construction, ground disturbing activities could impact surface waters through increased runoff and sedimentation. Such impacts relate to the amount of land disturbed, the type of soil at the site, the topography, and weather conditions. They would be minimized by application of standard management practices for stormwater and erosion control (sediment fences, mulching disturbed areas).

During operations, surface waters could be affected by increased runoff from parking lots, buildings, or other cleared areas. Stormwater from these areas could be contaminated with materials deposited by airborne pollutants, automobile exhaust and residues, materials handling releases such as spills, and process effluents. Impacts of stormwater discharges could be highly variable and site specific, and mitigation would depend on management practices, the design of holding facilities, the topography, and adjacent land use. Data from existing water quality databases were compared with expected discharges from the facilities to determine the potential for and the relative impacts on surface waters.

Groundwater Quality—Potential groundwater quality impacts associated with any effluent discharges and other contaminant releases during facility construction and operation activities were examined. Available engineering estimates of contaminant concentrations were weighed against applicable Federal and state groundwater quality standards, effluent limitations, and drinking water standards to determine the impacts of each alternative. Also evaluated were the consequences of groundwater use and effluent discharge on other site groundwater conditions.

A.6.2.3 Waterways and Floodplains

The locations of waterways (ponds, lakes, streams) and the 100- and 500-year floodplains were identified from maps and other existing documents to assess the potential for impacts from facility construction and operation activities, including direct effects on hydrologic characteristics or secondary effects such as sedimentation (see Surface Water Quality in Section A.6.2.2.). All activities would be conducted to avoid delineated floodplains and to ensure compliance with Executive Order 11988, *Floodplain Management*. However, for any facilities proposed for location in a floodplain, a floodplain assessment would be prepared.

A.7 ECOLOGICAL RESOURCES

A.7.1 Description of Affected Resources and Region of Influence

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. The region of influence for the ecological resource analysis encompassed the site and adjacent areas potentially disturbed by construction and operation of the candidate facilities.

Terrestrial resources are defined as those plant and animal species and communities that are most closely associated with the land; for aquatic resources, a water environment. Wetlands are defined by the U.S. Army Corps of Engineers and EPA as "… those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR Section 328.3).

Endangered species are defined under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) as those in danger of extinction throughout all or a large portion of their range. Threatened species are defined as those species likely to become endangered within the foreseeable future. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service propose species to be added to the lists of threatened and endangered species. They also maintain a list of "candidate" species for which they have evidence that listing may be warranted, but for which listing is currently precluded by the need to list species more in need of Endangered Species Act protection. Candidate species do not receive legal protection under the Endangered Species Act, but should be considered in project planning in case they are listed in the future. Critical habitat for threatened and endangered species is designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management consideration or protection. States may also designate species as endangered, threatened, sensitive protected, in need of management, of concern, monitored, or species of special concern.

A.7.2 Description of Impact Assessment

Impacts to ecological resources may occur as a result of land disturbance, water use, air and water emissions, human activity, and noise associated with project implementation (see **Table A–9**). Each of these factors was considered when evaluating potential impacts from the proposed action. For those alternatives involving construction of new facilities, direct impacts to ecological resources was based on the acreage of land disturbed by construction. Indirect impacts from factors such as human disturbance and noise were evaluated qualitatively. Indirect impacts to ecological resources, including wetlands, from construction due to erosion were evaluated qualitatively, recognizing that standard erosion and sediment control practices would be followed. Impacts to terrestrial and aquatic ecosystems and wetlands from water use and air and water emissions were evaluated based on the results of the analyses conducted for air quality and water resources. The determination of impacts to threatened and endangered species was based on similar factors as noted above for terrestrial resources, wetlands, and aquatic resources.

Table A–9 Impact Assessment Protocol for Ecological Resources

Resource	Required Data		Measure of Impact
	Affected Environment	Alternative	
Terrestrial resources	Vegetation and wildlife within vicinity of facilities	Facility location and acreage requirement, air and water emissions, and noise	Loss or disturbance to terrestrial habitat; emissions and noise values above levels shown to cause impacts to terrestrial resources
Wetlands	Wetlands within vicinity of facilities	Facility location and acreage requirement, air and water emissions, and wastewater discharge quantity and location	Loss or disturbance to wetlands; discharge to wetlands
Aquatic resources	Aquatic resources within vicinity of facilities	Facility air and water emissions, water source and quantity, and wastewater discharge location and quantity	Discharges above levels shown to cause impacts to aquatic resources; changes in water withdrawals and discharges
Threatened and endangered species	Threatened and endangered species and critical habitats within vicinity of facilities	Facility location and acreage requirement, air and water emissions, noise, water source and quantity, and wastewater discharge location and quantity	Measures similar to those noted above for terrestrial and aquatic resources

A.8 CULTURAL AND PALEONTOLOGICAL RESOURCES

A.8.1 Description of Affected Resources and Region of Influence

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. For this *CMRR EIS*, potential impacts were assessed separately for each of the three general categories of cultural resources: prehistoric, historic, and Native American. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age, and may be sources of information on ancient environments and the evolutionary development of plants and animals. Although not governed by the same historic preservation laws as cultural resources, they could be affected by the proposed action in much the same manner.

Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield otherwise inaccessible information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with Cold War themes. Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. Such resources may include geographical features, plants, animals, cemeteries, battlefields, trails, and environmental features. The region of influence for the cultural and paleontological resource analysis encompassed the site and areas adjacent to the site that are potentially disturbed by construction and operation of the candidate facilities.

A.8.2 Description of Impact Assessment

The analysis of impacts to cultural and paleontological resources addressed potential direct and indirect impacts at each candidate site from construction and operation (see **Table A–10**). Direct impacts include those resulting from groundbreaking activities associated with new construction and possibly building modifications. Indirect impacts include those associated with reduced access to a resource site, as well as impacts associated with increased stormwater runoff, increased traffic, and visitation to sensitive areas.

Table A–10 Impact Assessment Protocol for Cultural and Paleontological Resources

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Prehistoric resources	Prehistoric resources within the vicinity of facilities	Facility location and acreage requirement	Potential for loss, isolation, or alteration of the character of prehistoric resources; introduction of visual, audible, or atmospheric elements out of character
Historic resources	Historic resources within the vicinity of facilities	Facility location and acreage requirement	Potential for loss, isolation, or alteration of the character of historic resources; introduction of visual, audible, or atmospheric elements out of character
Native American resources	Native American resources within the vicinity of facilities	Facility location and acreage requirement	Potential for loss, isolation, or alteration of the character of Native American resources; introduction of visual, audible or atmospheric elements out of character
Paleontological resources	Paleontological resources within the vicinity of facilities	Facility location and acreage requirement	Potential for loss, isolation or alteration of paleontological resources

A.9 SOCIOECONOMICS

A.9.1 Description of Affected Resources and Region of Influence

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics of a region. The number of jobs created by the proposed action could affect regional employment, income, and expenditures. Job creation is characterized by two types: (1) construction-related jobs, which are transient in nature and short in duration, and thus less likely to impact public services; and (2) operation-related jobs, which would last for the duration of the proposed project, and thus could create additional service requirements in the region of influence.

The region of influence for the socioeconomic environment represents a geographic area where site employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. Site-specific regions of influence were identified as those counties in which approximately 90 percent or more of the site's workforce reside. This distribution reflects an existing residential preference for people currently employed at LANL and was used to estimate the distribution of workers associated with facility construction and operation under the proposed alternatives.

A.9.2 Description of Impact Assessment

Data were compiled on the current socioeconomic conditions near LANL, including unemployment rates, economic area industrial and service sector activities, and the civilian labor force. The workforce requirements of each alternative were determined in order to measure their possible effect on these socioeconomic conditions. Although workforce requirements may be able to be filled by employees already working at LANL, it was assumed that new employees would be hired to ensure that the maximum impact was assessed. Census statistics were also compiled on population, housing demand, and community services. U.S. Census Bureau population forecasts for the region of influence were combined with overall projected workforce requirements for each of the alternatives being considered to determine the extent of impacts on housing demand and levels of community services (see **Table A–11**).

Table A–11 Impact Assessment Protocol for Socioeconomics

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Regional Economic Characteristics			
Workforce requirements	Site workforce projections	Estimated construction and operating staff requirements and time frames	Workforce requirements added to sites' workforce projections
Region of influence civilian labor force	Labor force estimates	Estimated construction and operating staff requirements and time frames	Workforce requirements as a percentage of the civilian labor force
Employment	Latest available employment in counties surrounding sites	Estimated construction and operating staff requirements	Potential change in employment
Demographic Characteristics			
Population and demographics of race, ethnicity, and income	Latest available estimates by county from the U.S. Census Bureau	Estimated effect on population	Potential effects on population
Housing and Community Services			
Housing – percent of occupied housing units	Latest available ratios from the U.S. Census Bureau	Estimated housing unit requirements	Potential change in housing unit availability
Education - Total enrollment - Teacher-to-student ratio	Latest available information from the U.S. Department of Education	Estimated effect on enrollment and teacher-student ratio	Potential change in student enrollment Potential change in teacher-student ratio
Health care – number of hospital beds and physicians per 1,000 residents	Latest available rates from the U.S. Census Bureau	Estimated effect on ratio	Potential change in the availability of hospital beds/physicians-population ratio

A.10 WASTE MANAGEMENT AND POLLUTION PREVENTION

A.10.1 Description of Affected Resources and Region of Influence

Depending on the alternative, construction and operation of the candidate facilities would generate several types of waste. Such wastes may include the following:

- Transuranic waste: Radioactive waste not classified as high-level radioactive waste and containing more than 100 nanocuries per gram of alpha-emitting transuranic isotopes with half-lives greater than 20 years.

- Mixed transuranic waste: Transuranic waste that also contains hazardous components regulated under the Resource Conservation and Recovery Act (42 U.S.C. 6901 et seq.).

- Low-level radioactive: Waste that contains radioactivity and is not classified as high-level radioactive waste, transuranic waste, or spent nuclear fuel, or the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the transuranic concentration is less than 100 nanocuries per gram of waste.

- Mixed low-level radioactive: Low-level radioactive waste that also contains hazardous components regulated under the Resource Conservation and Recovery Act (42 U.S.C. 6901 et seq.).

- Hazardous: Under the Resource Conservation and Recovery Act, a waste that, because of its characteristics, may (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness, or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes appear on special EPA lists or possess at least one of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. This category does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act (42 U.S.C. 2011 et. seq).

- Nonhazardous: Discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. This category does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act (42 U.S.C. 2011 et. seq.).

The alternatives could have an impact on existing LANL facilities devoted to the treatment, storage, and disposal of these categories of waste. Waste management activities in support of the proposed action would be contingent on Records of Decision issued for the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (Waste Management PEIS)* (DOE 1997). In its Record of Decision for the Treatment and Management of Transuranic Waste (63 FR 3629), and subsequent revisions to this Record of Decision (65 FR 82985, 66 FR 38646, and

67 FR 56989, respectively), DOE decided (with one exception) that each DOE site that currently has or will generate transuranic waste would prepare its transuranic waste for disposal, and store the waste on site until it could be shipped to the Waste Isolation Pilot Plant in Carlsbad, New Mexico, for disposal. In the Record of Decision for hazardous waste, released on August 5, 1998 (63 FR 41810), DOE sites evaluated in this *CMRR EIS* will continue to use offsite facilities for the treatment and disposal of major portions of their nonwastewater hazardous waste. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed, and to the extent practical, onsite disposal of low-level radioactive waste will continue. Hanford and NTS will be made available to all DOE sites for the disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, the Idaho National Engineering and Environmental Laboratory, the Oak Ridge Reservation, and the Savannah River Site and will be disposed of at Hanford and NTS.

A.10.2 Description of Impact Assessment

Waste management impacts were assessed by comparing the projected waste stream volumes generated from the proposed activities with LANL's waste management capacities and generation rates (see **Table A–12**). Only the impacts relative to the capacities of waste management facilities were considered; other environmental impacts of waste management facility operations (human health effects) are evaluated in other sections of this *CMRR EIS*, or in other facility-specific or sitewide NEPA documents. Projected waste generation rates for the proposed activities were compared with site processing rates and capacities of those treatment, storage, and disposal facilities likely to be involved in managing the additional waste. The waste generation rates were provided by the sites' technical personnel. Potential impacts from waste generated as a result of site environmental restoration activities are not within the scope of this analysis.

Table A–12 Impact Assessment Protocol for Waste Management

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Waste management capacity - Transuranic waste - Mixed transuranic waste - Low-level radioactive waste - Mixed low-level radioactive waste - Hazardous waste - Nonhazardous waste	Site generation rates (cubic meters per year) for each waste type Site management capacities (cubic meters) or rates (cubic meters per year) for potentially affected treatment, storage, and disposal facilities for each waste type	Generation rates (cubic meters per year) from facility operations for each waste type	Combination of facility waste generation volumes and other site generation volumes in comparison to the capacities of applicable waste management facilities

A.11 CUMULATIVE IMPACTS

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Section 1508.7). The cumulative impact analysis for this *CMRR EIS* involved combining the impacts of the alternatives (including the No Action Alternative) with the impacts of other present and reasonably foreseeable activities in the regions of influence. The key resources are identified in **Table A–13**.

In general, cumulative impacts were determined by collectively considering the baseline affected environment (conditions attributable to present actions by DOE and other public and private entities), the proposed action (or no action), and other future actions. Quantifiable information was incorporated to the degree available. Factors were weighed against the appropriate impact indicators (site capacity or number of fatalities) to determine the potential for impact (see **Table A–14**).

Table A–13 Key Resources and Associated Regions of Influence

Resources	*Region of Influence*
Resource use	The site
Air quality	The site, nearby offsite areas within local air quality control regions, where significant air quality impacts may occur, and Class I areas within 100 kilometers
Human health	The site, offsite areas within 80 kilometers of the site, and the transportation corridors among the sites where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Waste management	The site

Table A–14 Selected Indicators of Cumulative Impact

Category	*Indicator*
Resource use	- Workers required compared with existing workforce - Electricity use compared with site capacity - Water use compared with site capacity
Air quality	Criteria pollutant concentrations and comparisons with standards or guidelines
Human health	Public - Maximally exposed offsite individual dose - Offsite population dose - Fatalities Workers - Total dose - Fatalities
Waste	- Low-level radioactive waste generation rate compared with existing management capacities and generation rate - Mixed low-level radioactive waste generation rate compared with existing management capacities and generation rate - Hazardous waste generation rate compared with existing management capacities and generation rate - Nonhazardous waste generation rate compared with existing management capacities and generation rate

The analysis focused on the potential for cumulative impacts at LANL from DOE actions under detailed consideration at the time of this *CMRR EIS*, as well as cumulative impacts associated with transportation. The *LANL SWEIS* was used to establish baseline conditions upon which incremental cumulative impacts were assessed.

It is assumed that construction impacts would not be cumulative because construction is typically short in duration, and construction impacts are generally temporary.

A.12 REFERENCES

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